THE ELEMENTS OF MAGNETISM AND ELECTRICITY

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OF
MAGNETISM
AND
ELECTRICITY.

BY
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FIFTH EDITION.

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PREFACE TO THE FIFTH EDITION.

Some years ago I was encouraged to write a small Text-Book for the instruction of a class in Natural Philosophy. When the subject of scientific instruction was taken up by the Science and Art Department I endeavoured to make my books useful in facilitating the attainment of sound elementary knowledge in science. My official work in connection with the Department, now extending over a period of fifteen years, has prevented my giving that attention to a revision of the books which from time to time appeared necessary. I felt the best thing I could do was to secure the co-operation and help of the most experienced and successful teachers of the sciences to which the books relate, so as to make them worthy the object for which they have been prepared.

J. C. BUCKMASTER.

St. John's Hill, Wandsworth, S.W.,
February, 1871.

SYLLABUS

ISSUED BY THE SCIENCE AND ART DEPARTMENT.

MAGNETISM AND ELECTRICITY.

First Stage, or Elementary Course.

Magnetism.

It is exceedingly desirable that the pupil's ideas of the fundamental facts and principles of magnetism should be as clear as our knowledge and his capacity can make them.

He ought to be made acquainted with the action of the natural magnet or loadstone on small pieces of iron. This is to be mentioned to him as the first fact observed, but for the explanation of which other facts are necessary. The action of two natural magnets upon each other ought to be described, and through this action a clear notion of the doctrine of *magnetic polarity* ought to be conveyed to the pupil's mind.

The power of the natural magnet to confer its own magnetic properties upon steel, and the action of the natural magnet on the steel which it has magnetized, ought to be explained.

The action of two pieces of magnetized steel upon each other ought to be made clear, and from this action the fundamental law that like poles repel each other, and that unlike poles attract each other, ought to be deduced.

The distribution of magnetism in a bar magnet ought to be made clear. The effect of breaking the magnet into two halves; the effect of again breaking these halves; and through facts of this nature, a clear idea is to be conveyed that each molecule of the magnet is itself a magnet; the action of the magnet as a whole being the sum of the actions of its molecules.

It is of exceeding importance that the pupil should be taught to connect the facts of magnetism by means of the provisional conception known as *the theory of magnetic fluids*. The teacher will assure himself that a correct image of this theory is in the pupil's mind. He will at the same time be careful to inform the pupil that the theory is an image merely, which enables him to connect and classify his facts, and that it is not a proved scientific truth.

The theory is to be applied in explaining the difference between iron and steel as regards their power of accepting and retaining magnetism. The term *coercive force* and all that relates to it will here come under review.

The theory is also to be applied in explaining the first observed facts of magnetism, including in them, and illustrating by them, the general phenomena of magnetic induction, or magnetization by influence. Every student ought to have a clear image of the state of a piece of iron acted on by a magnet, and he ought to be able to explain why the attraction of the iron is a consequence of that state. He ought clearly to see that repulsion as well as attraction is at work, the resultant attraction being the difference of both.

He ought to understand that when the attracting magnet is very distant, the difference between attraction and repulsion is so small as to be imperceptible; this knowledge will render it easy for him to comprehend why the magnetic poles of the earth which give *direction* to a magnetic needle are incompetent to produce a motion of translation.

The pupil ought to know the facts of terrestrial magnetism; why it is that we consider the earth a magnet. It will be possible to make him acquainted with all that is known regarding the position of the earth's magnetic equator and of the terrestrial magnetic poles.

The terms declination (variation), inclination (dip), and magnetic intensity, ought to be explained to him.

Frictional Electricity.

Here also care must be taken to imprint the fundamental facts and principles clearly and firmly upon the pupil's mind. It is easy in the case of frictional electricity to let the pupil actually see some of the facts; and it is exceedingly desirable that he should do so. The same remark applies to the elementary facts of magnetism.

As in the case of magnetism, the fact first observed, namely, the attraction of light bodies by rubbed amber, must be shown to need other facts for its explanation.

The mode of exciting bodies by friction is to be described; the action of rubbed and unrubbed vitreous bodies upon each other; the action of rubbed and unrubbed resinous bodies upon each other; and the action of vitreous bodies upon resinous bodies, and the reverse, are to be clearly described and illus-

trated. From these facts the law is to be deduced that bodies similarly electrified repel, and dissimilarly electrified attract each other. The pupil ought to know why the terms vitreous and resinous, as applied to electricity, have been abandoned.

Having been made acquainted with the elementary facts and principles, the pupil is to be rendered familiar with the provisional conception called the theory of electric fluids. As in the case of magnetism, he is to understand that this theory is an image merely, and not a truth.

He ought to be made acquainted, by experiments performed or described, with the qualities of insulation and conduction. He ought to know the reason of the old division of bodies into electrics and non-electrics, and also the unsound character of this classification.

Clear definitions ought to be given as to what is to be understood by positive and what by negative electricity. The pupil must be able to determine the quality of the electricity with which any body is charged.

He must be thoroughly versed in the phenomena of electric induction, and must be able to apply the theory of electric fluids in the explanation of these phenomena. In connection with the subject of electricity this is the most important part of the teacher's duty, for upon a knowledge of the facts and principles of electric induction the comprehension of almost all that follows it depends.

The pupil ought to be able to construct, or describe the construction, of an electrophorus, and to explain its action by reference to the principles of electric induction.

He ought to be able to explain the condenser by reference to the same principles.

He ought to be able to explain the charging and discharging of the Leyden jar by reference to the same principles.

He ought to be able to describe the charging of the prime conductor of an electric machine by reference to the same principles.

The knowledge implied in the last three questions embraces that of the construction of the condenser, the Leyden jar, and the electric machine. The first form of the Leyden jar ought to be known to the pupil.

The distribution of electricity on the surfaces of conductors is to be made known, and from it the power of points to disperse electricity ought to be deduced. The pupil ought to realize that in virtue of its self-repelling character an electric fluid always moves to the external surfaces of bodies. The power of flames